



Chondrolaryngoplasty in transgender women: Prospective analysis of voice and aesthetic satisfaction

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ABSTRACT

Introduction: Chondrolaryngoplasty or “tracheal shaving” is cosmetic surgery to reduce the laryngeal prominence in transgender women. Complications may include damage to the vocal folds and epiglottic destabilization or aesthetic dissatisfaction.

Objective: To assess and compare acoustic and perceptual voice outcomes and aesthetic satisfaction of transgender women submitted to chondrolaryngoplasty.

Methods: Prospective interventional cohort of transgender women submitted to chondrolaryngoplasty between March 2018 and October 2019. Voice analysis included simple-blind application of the GRBAS Hirano scale by speech therapist and measurement of the fundamental frequency, in the preoperative and 1-month postoperative periods. The visual analog scale was used to analyze the aesthetic satisfaction, before and 6-months after chondrolaryngoplasty.

Results: Fifteen patients participated, with a mean age of 31.7 ± 8.3 years (range 22–51 years). The mean postoperative follow-up period was 15.3 ± 6.1 months (range 6–25 months). There was a significant improvement in the visual analog scale for aesthetic satisfaction, with a preoperative mean = 0.7 ± 1.0 and a postoperative mean = 9.3 ± 1.1 (95% CI for difference = 7.3 to 9.6; $p < 0.001$). All patients presented a positive variation. The preoperative mean fundamental frequency was 171.3 ± 41.2 Hz and the postoperative, 177.1 ± 39.5 Hz, with no statistical significance (95% CI for difference = -30.1 to 41.7 ; $p = 0.74$). There was no statistically significant difference in the pre- and postoperative comparison of each component of the GRBAS scale. One (7%) patient presented a hyperpigmented scar and 2 (13%) reported hoarseness during the first postoperative week. There were no major complications such as disinsertion of the epiglottis or vocal folds.

Conclusion: Chondrolaryngoplasty led to significant aesthetic satisfaction in transgender women. The surgery caused no noticeable vocal change in pitch or perception.

KEYWORDS

Sex reassignment procedures; surgery; thyroid cartilage; transgender persons; voice

Introduction

Gender dysphoria is estimated to occur in over 1 million people in the United States (Massenburg et al., 2018). The laryngeal prominence demarcated in the cervical region, commonly known as the “Adam’s apple,” is one of the stigmatizing secondary sexual characteristics of men and it is a notable obstacle to the full exercise of transgender women’s social and professional role (Wolfort & Parry, 1975).

Chondrolaryngoplasty or “tracheal shaving” is cosmetic surgery to reduce the cervical projection of the laryngeal prominence, initially described by Wolfort and Parry (1975) and modified by

Wolfort et al. (1990). It involves a resection of the thyroid cartilage in the anterosuperior region, preserving the insertion area of the anterior commissure of the vocal folds. It is frequently performed on transgender women, but it can also be indicated for cisgender men or women who feel uncomfortable with the projection (Jotz et al., 2014; Parker, 2008; Spiegel & Rodriguez, 2008).

In retrospective studies, around 85% of patients submitted to chondrolaryngoplasty report improvements in the appearance of the laryngeal prominence and satisfaction with the scar (Matai et al., 2003). Complications, although rare, may include damage to the vocal folds and epiglottic destabilization. (Spiegel & Rodriguez, 2008).

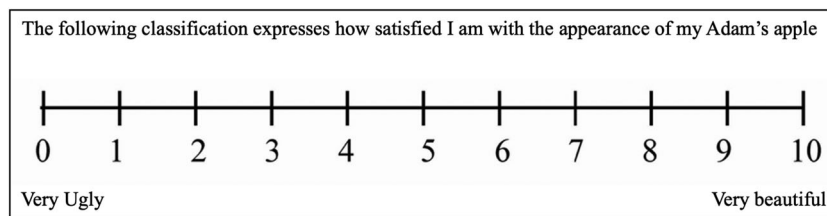


Figure 1. Visual Analog Scale (VAS) for esthetic satisfaction of laryngeal prominence.

To the best of our knowledge, to date, there has been no prospective study in the literature that analyzes the aesthetic and functional results of chondrolaryngoplasty. Thus, the objectives of this research were to assess safety, consequence on voice quality, and effectiveness (i.e., subjective aesthetic satisfaction) of chondrolaryngoplasty in transgender women.

Materials and methods

Ethical considerations

This study was conducted in accordance with the 1964 Helsinki Declaration and was approved by the ethics committee of Universidade Federal de Pernambuco (number: 3,055,585). Informed consent was obtained from each patient.

Study design and patients

This was a prospective interventional cohort, conducted at the Hospital das Clínicas da Universidade Federal de Pernambuco. The recruitment period was from March 2018 to October 2019. The population consisted of consecutive transgender women diagnosed with gender identity disorder, according to the criteria of the World Professional Association for Transgender Health Inc. (Coleman et al., 2012), monitored for at least 2 years in the hospital, with aesthetic dissatisfaction regarding the laryngeal prominence. This preoperative follow-up period in a multidisciplinary team is a prerequisite of the National Health System for gender-affirming surgery in public hospitals, in compliance with ordinances 2803/2013 of the Ministry of Health and 1652/2002 of the Federal Council of Medicine. The exclusion criteria established were: follow-up period of less than 6 months, presenting with clinical or psychiatric comorbidity prohibiting surgical treatment or

inappropriate physical characteristics for the procedure.

Pre- and postoperative assessment

Eligible patients were assessed by photographic records of the laryngeal prominence and laryngostroboscopy by a senior laryngologist. For subjective analysis of the laryngeal prominence, we used a visual analog scale (VAS) for aesthetic satisfaction, graded from 0 (very ugly) to 10 (very beautiful), applied at the preoperative consultation and in the sixth postoperative month, based on the Utrecht questionnaire validated for aesthetic rhinoplasty (Figure 1) (Rosa et al., 2019).

To assess the effects of the surgical procedure on vocal quality, voice recordings were made in the immediate preoperative period and on the thirtieth postoperative day. Samples were recorded digitally in a quiet environment using a directional microphone (Auricular Karsect HT-2°) placed 6.0 cm from the mouth. Voice recordings were stored for later acoustic analysis independently using Voxmetria® (CTS Play). The voice of each patient was recorded in an individual sound file and anonymously labeled. These samples were randomized, and voice assessment was performed blindly by one experienced listener, who did not participate in the research. The objective data analyzed were the fundamental frequency (F0) and the auditory-perceptual voice assessment with the GRBAS scale (Hirano, 1981). Four patients were excluded from this analysis since they had also undergone additional concurrent pitch-raising vocal surgery.

Technique

All patients were submitted to chondrolaryngoplasty under general anesthesia and orotracheal intubation, by the same team of otolaryngologists (the authors), using the same surgical technique.

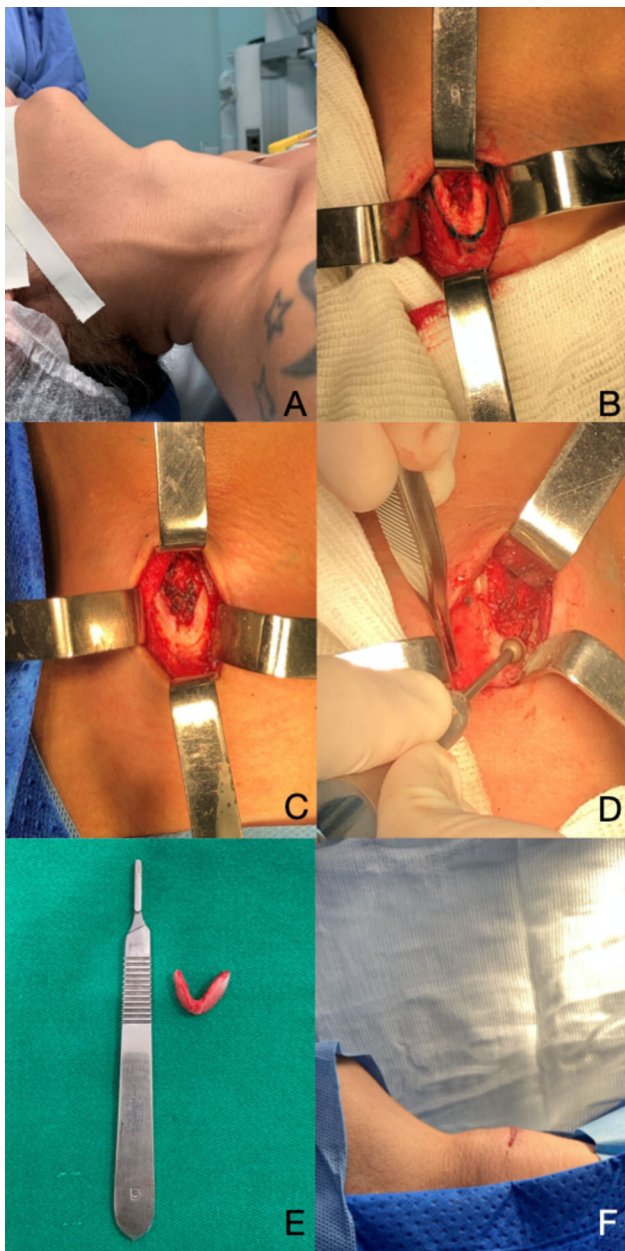


Figure 2. Surgical steps. A: surgical positioning with a cushion under the shoulders and a head ring to support the head. B: marking the area of the thyroid cartilage to be resected, 3 mm away from the midpoint of the cartilage height. C: cartilage appearance after resectioning the prominence. D: smoothing and flattening of the edges of the remaining thyroid cartilage. E: resected portion of the thyroid cartilage, in a “V” shape. F: immediate postoperative aspect of the surgical wound, in profile.

A median transverse anterior cervical incision of 3 cm was made in a previous cervical cutaneous fold over the larynx and an upper and lower subplatysmal flap was created. After dieresis of the muscle planes, the thyroid cartilage was exposed. The external and internal perichondrium from

the region of the laryngeal prominence to be resected were detached. The height of the thyroid cartilage was then measured and the midpoint of the distance between the thyroid notch and the lower margin of the thyroid cartilage (projection of the anterior commissure of the vocal folds) was identified, an area that must be preserved to avoid disinsertion of the vocal folds. After delimiting a safe margin of 3 mm above the midpoint of the height of the thyroid cartilage, the laryngeal prominence and the upper portion of the cartilage were resected in a “V” shape, also including the upper border along the thyroid notch. For this resection, a scalpel blade number 15 and/or a 2 mm surgical cutting burr was used (if calcified cartilage, especially in patients aged over 40). After resection, a crucial step in this procedure was to smooth the edges and flatten the residual laryngeal prominence with a 4 mm diamond burr. The external and perichondrium were repositioned over the excised cartilage area, without placing suture. Finally, the planes were then closed, followed by intradermal suture, without placing a drain (Figures 2 and 3).

The surgical technique used was based on that described by Wolford and Parry (1975), with two modifications. As a parameter for the height of the anterior commissure of the vocal folds, instead of the insertion the thyroepiglottic ligament - located in a higher position - we used the midpoint of the height of the thyroid cartilage, with an additional safety margin of 3 mm, based on measurements defined through a consistent tomographic study (Sagiv et al., 2016). In addition to this, we also introduced the use of the diamond burr to flatten the remaining thyroid cartilage, thereby enabling major remodeling without a temerarious resection.

During the postoperative period, relative rest was recommended for 15 days with no physical or work activities. In addition, patients were advised to protect the scar area from sun exposure for two months, in order to avoid hyperpigmentation.

Statistical analysis

Statistical analysis was performed using SPSS 23.0 (IBM, Armonk, NY). Descriptive statistics were presented as mean \pm standard deviation with a

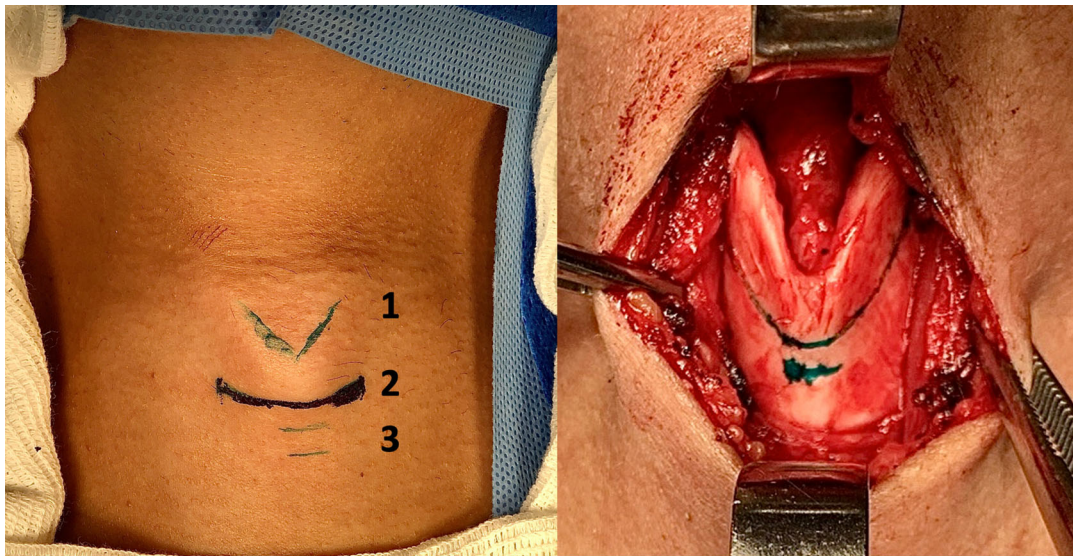


Figure 3. On the left, preoperative skin demarcation: thyroid notch (1), incision line (2) and upper and lower edges of the cricoid cartilage (3). On the right, detail of the marking the area of the thyroid cartilage to be resected, 3 mm away from the midpoint of the cartilage height.

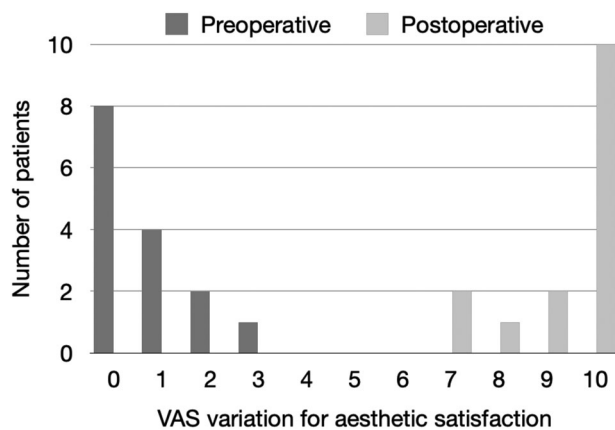


Figure 4. Pre- and postoperative Visual Analog Scale. Abbreviations: VAS, Visual Analog Scale. Distribution of VAS grades for esthetic satisfaction, before (mean = 0.7 ± 1.0) and after surgery (mean = 9.3 ± 1.1). Difference of means = 8.6 ± 1.9 ($p < 0.001$; CI 95% 7.3–9.6).

95% confidence interval (CI) for continuous variables, and as frequencies (%) for categorical ones. Statistical significance was compared using a Wilcoxon Signed Rank test, because of the small number of patients and the non-normal distribution of the variables. Results were considered statistically significant when the p -value was less than 0.05.

Results

A total of 15 patients were included. The mean age was 31.7 ± 8.3 years (range 22 to 51 years). The

mean time of multidisciplinary monitoring at the service before undergoing chondrolaryngoplasty was 3.6 years (range 2 to 9 years). The mean number of surgeries prior to chondrolaryngoplasty was 1.2. Laryngostroboscopy examinations were normal in all patients. The average postoperative follow-up time was 15.3 ± 6.1 months (range 6 to 25 months).

Aesthetic satisfaction

Fifteen (100%) patients presented a positive variation in the VAS score when comparing the pre- and postoperative appearance of laryngeal prominence. Before surgery, 8 (53%) patients had graded the appearance of the laryngeal prominence as 0, while in the postoperative period, 10 (67%) patients graded it as 10 (Figure 4). The mean value of the preoperative VAS was 0.7 ± 1.0 and postoperative, 9.3 ± 1.1 , with a mean improvement of 8.6 ± 1.9 , with statistical significance ($p < 0.001$; 95% CI 7.3–9.6). Front and side comparison photographs are presented in Figures 5–7.

Voice analysis

Voice analysis was performed with 11 patients, since 4 patients were excluded due to additional concurrent pitch-raising vocal surgery. In the



Figure 5. Photographs with profile and front views, preoperative (left) and six months after surgery (right), patient #1.

assessed patients, the mean pre-operative fundamental frequency was 171.3 ± 41.2 Hz and in the post-operative, 177.1 ± 39.5 Hz, with a mean difference of 5.8 ± 10.5 Hz, with no statistical significance ($p = 0.74$; 95% CI = -30.1 to 41.7). In the individual analysis, 8 (73%) patients demonstrated an increase in fundamental frequency and 3 (27%), a decrease, with no trend pattern (Figure 8). There was no statistically significant difference in the GRBAS scale of the mean value of each of the five categories before and after surgery (Table 1).

Amongst the complications, one patient (7%) presented with a hyperpigmented scar and two (13%) reported hoarseness during the first postoperative week, which was overcome without the need for specific treatment. There were no major complications such as disinsertion of the epiglottis or vocal folds.

Discussion

A number of factors may influence patient satisfaction with cosmetic surgery, such as culture, life experience and particularly expectations on the



Figure 6. Photographs with profile and front views, preoperative (left) and six months after surgery (right), patient #2.

final result, which may or may not be realistic. Although the procedure may often be considered a success by the surgeon, the patient may not be satisfied, for which the opposite is also true (Cohen et al., 2018; Hellings & Trenité, 2007).

Cohen et al. (2018), in a retrospective study, indicated that 60% of the 31 patients who underwent chondrolaryngoplasty were “very” or “completely” satisfied. The reasons put forward for this frustration were the scar and the remaining size of the prominence. In another retrospective study, Matai et al. (2003) reported that 86% of the 35 patients who underwent chondrolaryngoplasty,

consulted years later by telephone, expressed aesthetic improvement, while 14% stated that they had noticed no change in the cervical appearance of the laryngeal prominence.

As a tool for analyzing aesthetic satisfaction, we used the VAS, a simple instrument that provides an assessment of the surgeon’s performance and is useful for comparison of the patient. Furthermore, it is easily reproducible and comparable between studies (Rosa et al., 2019). In our sample, all patients demonstrated aesthetic satisfaction after surgery, whereby 80% of the VAS scores were between 9 and 10. We used the



Figure 7. Photographs with profile and front views, preoperative (left) and six months after surgery (right), patient #3.

diamond burr to flatten the remaining thyroid cartilage, thereby enabling major remodeling without a temerarious resection, perhaps one of the key points for surgical success. Other methods of laryngeal contouring may include rongeur and Mayo scissors (Therattil et al., 2019).

It was demonstrated, prospectively and objectively, that there was no permanent vocal change in any of the patients during the postoperative period. Two patients reported hoarseness in the first week, possibly due to transient laryngeal edema from surgical manipulation or even by orotracheal intubation, which was resolved itself

without the need for any specific treatment. The variation observed in the F0 and in the GRBAS had no statistical significance and is probably part of the daily changes within the normal range of each individual (McGlinchey et al., 2011). The F0 presents a great intra-speaker variation, and is influenced by speech style, vocal effort, emotional state, stress level and even by a night of sleep deprivation (González et al., 2002). Cohen et al. (2018) also noted no vocal complications from chondrolaryngoplasty. Matai et al. (2003) reported that 9% of the consulted patients subjectively considered that the voice was only

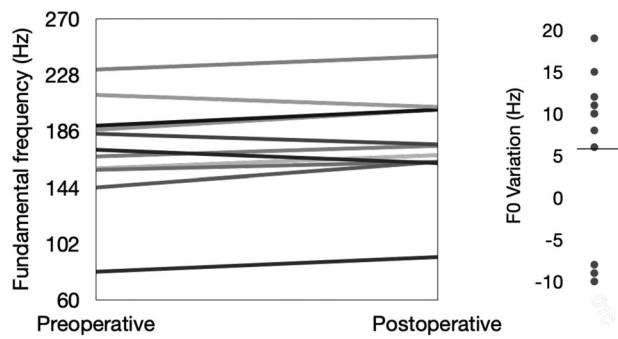


Figure 8. Pre- and postoperative fundamental frequency. Abbreviations: F0, fundamental frequency; Hz, Hertz. Mean F0 (Hz): Preoperative = 171.3 ± 41.2 Hz, and postoperative = 177.1 ± 39.5 Hz. Each line represents 1 patient. Mean variation = $5.8 \text{ Hz} \pm 10.5 \text{ Hz}$ ($p = 0.74$; CI 95% = -30.1 to 41.7).

Table 1. Overall pre- and postoperative voice assessments (GRBAS scale).

	Preoperative Mean (SD)	Postoperative Mean (SD)	Mean Difference (CI 95%)	<i>p</i> -value
Grade	0.91 (0.31)	0.72 (0.25)	-0.19 (-0.07 to 0.43)	.50
Roughness	0.63 (0.21)	0.45 (0.15)	-0.18 (-0.01 to -0.34)	.30
Breathiness	0.45 (0.15)	0.45 (0.15)	0 (-0.13 to 0.13)	.97
Asthenia	0 (0)	0 (0)	NA	.97
Strain	0 (0)	0 (0)	NA	.97

Abbreviations: SD, Standard Deviation; CI, Confidence Interval; NA, not applicable.

temporarily “slightly” or “moderately” different, compared to the preoperative.

Chondrolaryngoplasty represents a challenge for the surgeon in seeking a balance between aesthetics and function: a very conservative resection of the thyroid cartilage may lead to aesthetic dissatisfaction, while excessive resection may destabilize the anterior commissure tendon, thereby signifying permanent vocal damage, with hoarseness and decrease in vocal pitch. This complication would be tragic for a transgender woman, who undergoes elective cosmetic surgery for feminization. A wide preoperative discussion is recommended on these tenuous limits in order to adjust expectations.

The two techniques described in the literature demonstrate different strategies in order to avoid disinsertion of the anterior commissure of the vocal folds. Wolfort and Parry (1975) recommended detachment of the internal perichondrium from the upper portion of the thyroid cartilage only up to the insertion level of the thyroepiglottic ligament. As the insertion of the vocal ligament is inferior to the thyroepiglottic ligament, a safe limit is established. Later, Spiegel and Rodriguez (2008) described a surgical

approach using a laryngeal mask airway combined with intra-operative fiberoptic laryngoscopy examination to mark the implantation height of the anterior commissure in the thyroid cartilage with a 22-gauge needle, and consequently at the safe limit of the resection of the thyroid cartilage.

In our study, the midpoint of the height of the thyroid cartilage was used as a parameter for insertion of the anterior commissure, with an additional safety margin of 3 mm. This parameter for localization of the anterior commissure was objectively measured by Sagiv et al. (2016) and Enver et al. (in press). It proved to be simple, easy to perform and safe. Furthermore, unlike Spiegel and Rodriguez (2008) technique, it can be executed under general anesthesia with endotracheal tube. We chose an airway approach using endotracheal tube because most patients underwent another sex reassignment procedure simultaneously (Wendler glottoplasty, vaginoplasty, augmentation mammoplasty and facial feminizing procedure). Furthermore, the thyroid cartilage excision could lead to blood in the airway causing vocal fold irritation and laryngospasm, as reported by Spiegel and Rodriguez (2008). In these situations, an endotracheal tube approach is recommended due to the duration of the procedure and safety in an anesthetic complication scenario. (Sturm & Chalet, 2019).

This study has several limitations. Initially, the number of participants was small, and no sample power calculation was performed to identify significant changes in the pre- and postoperative voice quality. Secondly, due to the study design and ethical aspects, it was not possible to establish a control group to eliminate the influence of the placebo effect. Moreover, there was no objective measurement of the laryngeal prominence before and after surgery, demonstrating in fact that there was a significant reduction.

Conclusion

Chondrolaryngoplasty with resection of the laryngeal prominence was a safe and effective procedure for the aesthetic adequacy of transgender women, with significant patient satisfaction regarding the postoperative cervical appearance. The surgery caused no noticeable vocal change either in

perception or frequency. There was no major complication of chondrolaryngoplasty in this study.

Acknowledgments

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Conflict of interest

The authors declare that they have no conflict of interest.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

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